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The Feeding Value and Physical Form of Roughages[1/]

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One of the most popular subjects in the trade and technical journals in the last ten years has been the pelleting of feeds for cattle and sheep. Over and over again the virtues of pelleting have been extolled. These include conserved storage and transportation space, adaptation to mechanical handling, less dust or fine losses, decreased bagging expenses, elimination of selective feeding, greater feed consumption, and faster more efficient gains. The idea of pelleting is not new. Concentrates have been available in pelleted or cubed form for many years. Nevertheless, the constant deluge of favorable results published in the farm papers have awakened a new and keen interest in the pelleting of feeds for livestock production. How well justified are the optimistic reports? Under what conditions are they valid? What are some of the disadvantages? These questions have been answered in part in the review by Esplin et al. (7) and in the summaries by Hogue (10), Smith (31) and Loosli (15).

The present discussion is another attempt to give you answers to questions posed in respect to feeding value and to describe the work being conducted with pelleted feeds at the Beef Cattle Research Branch at Beltsville, Maryland, and our outlying field stations.

How justified are the optimistic reports? The answer may best be provided by presenting some of the favorable results. Table 1 briefly summarizes some of the research on the effect of pelleting rations fed to fattening lambs.

These results represent only a small portion of the work in which lambs have been fed rations in various physical states but they may be considered representative of the responses observed in many other experiments. That is, increased feed consumption and more rapid daily gains may be expected when lambs are fed rations high in roughage content and in a pelleted form as compared to the same rations fed with the hay in the long, chopped, or coarse ground state.

The same comparisons may be found in beef cattle feeding experiments. The results of some of these comparisons are illustrated in table 2.

These results are not as clearcut as those with sheep but are suggestive of increased feed intakes and increased average daily gains when pelleted rations with high roughage content are fed.

What about the other side of the story? What are some of the disadvantages? Jensen et al. (11), working with lambs, first reported an abnormality of the ruminal epithelium called rumen parakeratosis which was associated with the feeding of pelleted rations. The lambs exhibiting parakeratosis gained less rapidly than the animals not having the condition. Since that time the condition has been observed by other investigators with beef cattle as well as with sheep (19,24).

With dairy cattle the pelleting of forages has been less than encouraging. Calves fed pelleted hay have done little, if any, better than calves getting the same hay in a chopped form (5). Abnormally low butterfat tests have been reported when pelleted rations were fed to dairy cows at the California (30), Kansas (9), and Arizona Experiment Stations (8). Similar but less consistent results were observed when ground and pelleted hays were fed at the Oregon (12), California and Connecticut Experiment Stations (22, 29). Fat tests were reported as low as one and one-half percent when pelleted rations were fed (8).

Long term studies being conducted by the Sheep Branch at Beltsville are showing larger losses of animals in the pellet-fed group (14). Feeding pellets as the sole diet for extended periods also appears to influence the development of the digestive tract and possibly some other organs. However, the data are limited at this time.

Another area in which the merits of pelleted rations may be questioned is with "fattening", high-concentrate rations. With lambs, feeding of pelleted, high concentrate rations has demonstrated little or no advantage in gains (14). With beef cattle the response to the feeding of pelleted high concentrate rations has been inconsistent, sometimes improving gains (13), sometimes improving feed efficiency (21), while at other times showing little advantage over the same ration fed in other physical forms (16).

When these nutritional advantages and disadvantages are considered, the next logical question that arises concerns the mechanism of the response or cause of the anomalies. Summarizing observations on the metabolic studies, Smith (31) concluded that pelleting or cubing roughages for complete rations does not increase the digestibility of feeds for ruminants and if a change occurs it is in the direction of a decrease in digestibility. Blaxter and Graham (2) determined the net energy value for dried grass in chopped and cubed forms and concluded there was no difference. Loosli (15) observed that if grinding and pelleting feeds does not increase the energy value, then the faster rate of gains usually observed with fattening lambs can only be explained on the basis of greater feed intake or a lower energy content of the tissues deposited.

Myer (20) postulated that the increase in feed intake resulting from grinding and pelleting hay is the direct result of a faster rate of digestion in the reticulo-rumen. The accelerated digestion allows a faster passage of feed through the digestive tract. The finer hay particle size might be the reason for this. The trial they conducted to test this hypothesis is summarized in table 3. These results were interpreted as suggesting that fine grinding may be a major factor favoring the increased feed consumption of a pellet and that pelleting serves to put dusty feeds into a more palatable form.

With dairy cattle the cause of the extreme milk fat depression has been related to changes in the fermentation reactions in the rumen when pelleted, finely ground, or heated feeds are fed in combination with the exclusion of coarse roughages (6). It is entirely possible that with an increased understanding of the mechanisms involved, this extreme depression in fat test may be prevented.

The pathogenesis of rumen parakeratosis has yet to be determined.

The study of physical state of feeds for rations and their feeding value by the Beef Cattle Branch at Beltsville and the field stations has paralleled State Experiment Station studies. In 1957 at the Front Royal, Virginia, Beef Cattle Research Station (25) ground, pelleted, and long hay rations for group-fed steers were compared. The results are summarized in table 4. The average gains were the same for the pelleted and ground rations but less feed (ten percent) was consumed by the pellet-fed group. The concentrate:roughage ratio was 3:2. The long hay-fed group consumed less feed and gained less weight. A similar ration was offered to individually fed steers at Beltsville in a later experiment (26). The ration was offered in the ground and pelleted forms as a mixture or with the grain and roughage portion offered separately but with the concentrate:roughage ratio being maintained constant. The results are summarized in table 5.

There were no differences in average daily gains but the pounds of feed consumed for each pound of gain were significantly less for the animals consuming the pelleted rations. Since the feed intake was not increased by pelleting, it appeared that a physical or chemical change may have occurred. Since the animals were individually fed in deep mangers, wastage was not considered a factor.

Further studies were conducted in 1960 (27). A high-roughage ration and a 60% concentrate ration were fed after being ground, ground and heated (125 - 150° F.) pelleted, and pelleted and reground. Bermuda grass was the roughage component of the rations. The results are presented in tables 6 and 7. The average gains were lower than anticipated for all treatments but, as was expected, were greater for the group receiving the concentrate in their ration. The animals receiving pelleted and pelleted and reground rations appeared to gain faster and more efficiently than the animals receiving the same ration ground or ground and heated. However, the response to physical state changes differed between rations. The average daily gain and feed consumption for the animals of the high roughage ration were larger when the ration was pelleted or pelleted and reground. On the contrary, the animals receiving the ration containing concentrates gained an equivalent amount but consumed less feed when the ration was pelleted. These trends agree with those present in the literature. While these trials were in progress at Beltsville other aspects of the problem were being studied at the Fort Reno Beef Cattle Research Station in Oklahoma. These studies were done in cooperation with the Oklahoma State University (17, 18).

The studies were concerned with the effect of the proportion of roughage in the ration and the response to pelleting. Rations containing concentrate to roughage ratios of 4 to 1 and 1 to 4 were compared.

The results showed little or no advantage to pelleting a high concentrate ration but indicated increased gains, consumption and feed efficiency when feeding the high roughage ration in a pelleted form. The experiment was repeated in 1960 with the same results (table 8). Furthermore, they fed a 1 to 4 concentrate to roughage ratio in a meal, pelleted and reground, and pelleted forms ad libitum and limited. The results (table 9) indicated to them that the increase of gains due to pelleting of the high roughage ration was due primarily to increased feed efficiency and feed intake.

Currently a feeding trial is in progress at Beltsville (28) in which a Bermuda grass-concentrate ration being fed in a ground, ground and heated (212° to 240° F.) and pelleted form is being compared to an alfalfa concentrate ration. The progress up to 56 days on feed is summarized in table 10.

One most important topic has not been mentioned in this discussion - the cost of grinding and pelleting. Estimates range from three to twelve dollars per ton for this service (1). The amount will undoubtedly vary with the proportion and type of roughage in the ration and the contractor doing the work and the equipment available. It is obvious that these costs must be less than the amounts saved by the nutritional advantage, labor, and storage space saved. If the practice is not economical at the present it may become so with future technological advances.

Summary

Some of the advantages and disadvantages of pelleting feeds or rations have been discussed. In addition to saving storage space and permitting the adaptation of mechanical handling, pelleting of a ration, especially a high roughage ration has often resulted in increased feed intake, increased bodyweight gains, and improved feed efficiency with both sheep and beef cattle. On the other hand, pelleting of a ration containing a high proportion of grain has shown little or no advantage for sheep and inconsistent results with beef cattle. Furthermore, animals consuming pelleted rations may develop pathological complications.

Metabolic studies have been interpreted as indicating that the response to pelleting of roughages can be explained primarily on the basis of increased feed consumption. There appear to be other unexplained factors involved when a ration containing a higher proportion of grain is fed.

Feeding of pelleted roughages or rations to dairy cattle has usually caused severe milk fat depression.

Recent work being conducted by the Beef Cattle Research Branch at Beltsville and concerned with the physical state and feeding value of rations was discussed.

Table 1

Feeding trials with lambs

Ref.	Ration		Average Daily (lb.) Gain	Feed Intake
Maine Poulton & Anderson 1960	Alfalfa Pellet		0.38	4.0
	Grind		0.20	2.0
	Chop		0.24	2.1
	Wafer		0.30	3.2
California Meyer 1959	Alfalfa Dehyd.	(Pelleted	0.42	3.8
		(Chopped	0.30	3.2
	Field Cured	(Pelleted	0.33	3.5
		(Chopped	0.16	2.3
Illinois Cate et al. 1958	Timothy + Corn, Mol., SBOM	(Meal	0.38	3.5
		(Pellet	0.50	3.8
	Timothy + Corn	(Meal	0.29	3.1
		(Pellet	0.45	3.5

Table 2

Feeding Trials with Steers

Ref.	Ration	Average Daily (lb.) Gain	Feed Intake
Illinois Webb & Cmarik 1957	Hay		
	Long	0.63	9.88
	Chop	0.62	9.27
	Pelleted	1.73	14.29
	Silage	0.05	6.13
Washington Dyer 1958	Mixed		
	Rough, Chop Conc.,Pelleted	2.61	20.9
	Rough.& Conc. Pelleted	2.90	18.4
	Rough.& Conc. Pelleted-fed Ad Lib.	3.20	21.6
Texas Stangel et al. 1958	Cottonseed hulls (Pelleted + 16.6# Sorghum, CSM, Alf.	2.42	16.9
	Cottonseed hulls (Loose + 16.6# Sorghum, CSM, Alf.	2.26	16.7

Table 3

Feeding Trials with Lambs. Meyer, 1959

	Ground	Pellet	Ground Plus Water	Reground Pellets Plus Water	Mean
Finely ground					
ADG	0.20	0.38	0.31	0.35	0.31
AD Feed	2.03	3.59	3.17	3.12	2.98
Chopped					
ADG	0.24	0.30	0.19	0.30	0.26
AD Feed	2.80	2.86	2.54	2.98	2.80

Table 4

Front Royal, Va. Priode, 1957

	Average daily (lb.)	
	Gain	Feed Intake
Ground hay and grain	2.11	22.2
Pelleted	2.13	19.9
Long hay and grain	1.81	19.3

Table 5

Feeding Trials with Steers	Putnam and Davis, 1959	
	Average daily (lb.)	
	Gain	Feed Intake
Mixed and ground	2.32	22.0
Separate and ground	2.71	24.8
Mixed and pelleted	2.51	21.2
Separate and pelleted	2.57	20.3

Table 6

Feeding Trials with Steers	Putnam and Davis, 1960	
	Average Daily (lb.)	
	Gain	Feed Intake
96% hay	1.01	16.6
38% hay	1.47	16.1
Ground	1.14	16.0
Heated	1.14	16.2
Pelleted	1.34	15.7
Reground	1.34	17.5

Table 7

Feeding Trials with Steers	Putnam and Davis 1960	
	Average Daily (lb.)	
	Gain	Feed Intake
96% Hay		
Ground	0.81	15.4
Heated	0.86	15.2
Pelleted	1.19	17.0
Reground	1.16	18.7
38% Hay		
Ground	1.46	16.6
Heated	1.42	17.2
Pelleted	1.49	14.3
Reground	1.52	16.4

Table 8

Feeding Trials with Steers		McCroskey et al. 1959 and 1960	
		Average Daily (lb.)	
Conc.:roughage		Gain	Feed Intake
1:4	(Pelleted	2.30	26.8
	(Ground	1.88	23.2
4:1	(Pelleted	2.25	19.9
	(Ground	2.33	22.2

Table 9

Feeding Trials with Steers	McCroskey et al. 1960	
	Average Daily (lb.)	
1:4 Conc.:Roughage	Gain	Feed Intake
Meal	1.89	23.0
Reground	2.14	24.2
Pellets	2.14	23.8
Pellets (limited)	1.96	21.3

Table 10

Feeding Trials with Steers	Putnam and Davis, 1961	
	Average Daily (lb.)	
	Gain	Feed Intake
Alf. ground	2.83	22.8
C. B. Ground	1.52	17.8
C. B. Heated	-1.00	10.6
C. B. Pelleted	1.87	16.8

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